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THE MATAMEK CONFERENCE ON BIOLOGICAL CYCLES, 1931[1]

By Dr. ELLSWORTH HUNTINGTON

YALE UNIVERSITY

DURING the last week of July, 1931, a biological conference of exceptional interest was held at the mouth of the Matamek River. This place is on the north side of the Gulf of St. Lawrence, 300 miles east of Quebec. The conference was called by Mr. Copley Amory, of Boston, and all its members were his guests. For years Mr. Amory has been interested in the fact that sometimes the fish, birds and mammals of that part of Canada are very abundant, and sometimes, for no apparent reason, very scarce. He has seen years when the cod were extremely abundant, and other years when practically no fish were caught. Salmon and all the animal population vary in the same inexplicable way. Therefore, at his summer home on the Matamek, Mr. Amory brought together about thirty scientists and Canadian officials to consider the problem of fluctuations among wild life.

The conference began in Quebec where its members were tendered an official luncheon at the beautiful Falls of Montmorency. Honorable Hector LaFerté, Provincial Minister of Colonization, Game and Fisheries, presided, and twenty or thirty other officials were present. The Canadian government as well as that of the Province of Quebec was much interested in the conference. Not only did Dr. Charles Camsell, Administrator of the Department of Mines, act as chairman, but the Forestry Branch, National Parks Branch, Department of Fisheries, National Museum, and Dominion Observatory were all officially represented. The interest of the Canadians was also evident in the fact that the Lower St. Lawrence Trans-

[1] Report by Ellsworth Huntington, Yale University, in collaboration with an editorial committee and approved by the conference.

portation Company sent its ship, the *North Shore,* on two special trips of 160 miles each in order to carry the conferees free of charge between Rimouski and Matamek.

Fluctuations of all sizes and sorts were discussed. They included not only irregular fluctuations, but cycles with lengths of anywhere from 30 months up to 260 years or more. Such fluctuations occur in trees, insects, fish of the sea, fish of the rivers, game birds, birds of prey, mice, rabbits and a dozen different fur-bearing animals that prey upon their smaller neighbors. They also occur in the bacteria and other parasites which cause epidemics among animals and sweep them away by the millions. Reproduction, diseases and deaths among human beings also came in for discussion. Agricultural fluctuations and even financial panics were not neglected. A number of solar, lunar and meteorological cycles were suggested as causes of the cycles in plants, animals and man.

Somewhat to the surprise of the conference the main discussion did not center around the well-known sunspot cycle of eleven years, but around shorter cycles of four years and especially nine or ten. The four-year cycle was described by Dr. A. O. Gross, of Bowdoin College, as being well shown by the migrations of the snowy owl into New England. Mr. Charles Elton, of Oxford, England, described the same cycle in far northern mice, lemmings and Arctic ptarmigan, and also in the Arctic fox and snowy owl which feed upon these lesser types of animals. He stated that similar cycles occur in Britain, and also in Norway where lemming migrations have been known for hundreds of years. In still another region, Alberta, Prof. William Rowan, of the University of Alberta, has found a similar four-year cycle in mice and probably shrews.

The regular course of events seems to be that the mice, lemmings and ptarmigan increase enormously in numbers for a season or two. Foxes, owls and other creatures are thus provided with abundant food. They, too, increase so fast that the number of skins brought in to the Hudson's Bay Company may be many times as great at one phase of the cycle as at another. Then there comes a change so sudden that the members of the conference call it the "crash." The rodents and game birds begin to die by the thousand or million. Some of them, such as the lemming, also migrate long distances, only to meet death in some other region. The creatures that have been feeding on them soon become hungry. They, too, begin to die, or else migrate to even greater distances. Snowy owls, for example, are described by Dr. Blair, of the New York Zoological Society, and by Dr. Gross as moving from Canada to southern New England and New York by the thousand. They generally perish, for they do not appear to return north, and they can not breed so far south. A similar cycle of increase and sudden decrease was described by Mr. Aldo Leopold, of Wisconsin, as occurring among the red grouse of Scotland, but there the period is six years instead of four.

The most remarkable feature of the biological conference was the great amount of evidence as to a cycle of nine or ten years. Mr. Leopold described such a cycle among the grouse and rabbits of Wisconsin and neighboring lake states. In the United States as a whole his figures seem to show that the increase and sudden decrease of these same animals take more nearly ten years, but further work may show that the two periods are really the same. One most interesting feature of the grouse is that those which live in the central and most favorable habitats apparently do not suffer violent fluctuations in numbers. The sufferers are those on the edges, which happen also to be the parts less densely populated by man. The findings of Mr. Leopold are confirmed by those of Dr. Gross who has studied the grouse in its more eastern habitat. Among the rabbits of Canada, however, Mr. Elton finds no evidence that fluctuations are less marked in the central area than on the margins. In fact, the opposite may be true, but all Canada is marginal in the sense that it is subject to great extremes of climate.

From the other side of the continent Prof. Rowan, of the University of Alberta, presented evidence that in the plains around Edmonton a cycle of almost ten years is evident in grouse, some other non-migratory birds, and rabbits, and also in their enemies such as the coyote and other fur bearers. Farther north in Canada the voluminous records of the Hudson's Bay Company have given Mr. Elton abundant data which show a cycle of about ten years, or more exactly 9.7, in hares, muskrats, grouse, lynxes, red fox, marten, wolf, mink and goshawks. The extraordinary thing about all this is not merely that many different animals show the same periodicity, but that the same period occurs in the far northwest of Canada, and all the way south into the United States. The increase or decrease in the animal population appears to begin in the far north and to work its way southward and eastward, reaching southern Canada after about three years. In spite of this the period of ten years or a little less is constant in each region.

Still more astonishing are the results of Dr. A. G. Huntsman, of Toronto University, Prof. E. B. Phelps, of Columbia University, and Prof. D. L. Belding, of Boston University Medical School. Using the records of the commercial catch of salmon in the bays along the coast of New Brunswick, Dr. Huntsman

found indications that the salmon come and go in periods of 9.6 years. Professors Phelps and Belding used the very careful records of the salmon caught by the members of the exclusive Ristigouche Club on the Ristigouche River in New Brunswick. Each fisherman there religiously records the weight and size of his fish and the number of days spent in fishing. Thus it is easy to calculate the daily number of fish per rod or angler for each of the last fifty years. There, too, the fish appear in great abundance every ten years, but sink to smaller numbers in the interim. Curiously enough it is not because large or small numbers are hatched in special years, although such may be the case. The greatest immediate cause of the change in numbers from year to year appears to be something which happens when the smolt, or young salmon, enter the sea.

From far away on the other side of the continent the measurement of the annual rings of growth in the giant sequoias of California, by Dr. Ellsworth Huntington, of Yale University, supplies still another type of evidence of this same cycle of about ten years. Thus once in ten years or less something seems to happen which causes an increase and then a decrease in the vital activities of both plants and animals. This occurs all over North America from the borders of Alaska to the Maritime Provinces and the northern United States, and also in the adjacent seas. Then, to complete the picture, Mr. Comsia, from Rumania, stated that he, too, has found some evidence of a ten-year cycle of disease in the rabbits not only of Canada, but possibly of Europe. The European disease is coccidiosis, which may turn out to be an important disease in Canada. Scraps of evidence, such as locust migrations, suggest that this same cycle prevails over still wider areas.

Most of the members of the conference expected that the sunspot cycle of 11.2 years would figure prominently at Matamek. Dr. H. Mayer-Wegelin, of the German Forestry School at Munden in Hanover, did indeed present evidence of an 11-year cycle in the growth of German trees. His colleague, Dr. H. S. Eidmann, showed that noxious insects which destroy the German trees have a cycle which is probably about 12 years. Mr. D. R. Cameron, of the Forestry Branch at Ottawa, pointed out that the increase of pests here and in Germany might be due to the influence of man in upsetting insect balance. Moreover, Mr. DeLury, of the Canadian Observatory at Ottawa, presented a large number of curves which seemed to show an 11-year cycle in tree-growth, agricultural production, the value of fish and the abundance of animals. Nevertheless, the more detailed studies presented by other members of the conference suggest that many of the 11- or 12-year cycles may fit equally closely into a cycle of between nine and ten years, averaging approximately 9.5.

One curious thing about this 9.5-year cycle is that while it can be detected in meteorological records, it has not been much studied there. Moreover, no basis for it, such as sunspots, has yet been found. Mr. DeLury pointed out that it is a little longer than the lunar cycle of 8.85 years and almost exactly half of another lunar cycle of 18.6 years. These two cycles of tidal activity may influence climate by stirring up the ocean waters, allowing cold water to come to the surface, and thus influencing atmospheric pressure and storms. This is not clear, however, and the conference felt that much more evidence was necessary before so seemingly minor a cause could logically be connected with such great events.

The magnitude of the action of these cycles is still more evidence from certain facts pointed out by Dr. Huntington. He showed that the most distinct cycle of droughts and of agricultural productivity in the United States has a period of 18.6 years if measured by the five cycles between 1837 and 1930. Moreover, during that same time there have been six financial panics separated by five average periods of 18.4 years. The panics, curiously enough, go with the agricultural depressions, but may precede or follow them. This suggests that the panics and the droughts may owe something to a common cause, even though the agricultural depression resulting from the droughts may not be the immediate cause of the panics. The conference made no attempt to solve such problems as this. It was, however, impressed by the fact that droughts, panics and agricultural depression not only show greater regularity than the sunspot cycles, but seem to have a periodicity twice that of the very regular cycles found in sequoia trees, rabbits, grouse, foxes, salmon and many other animals.

The evidence as to still larger cycles is scanty, but this may be due mainly to the absence of long records. Dr. Eidmann thinks that the noxious insects in the forests of Germany wax and wane in cycles of about thirty years. Professor Rowan finds a cycle of 34 years in the ducks, crows, magpies and lake levels of Alberta. The Brückner cycle of 30 or more years is also found by Mr. DeLury in several series of meteorological data and in the growth of trees. The salmon statistics studied by Professor Huntsman seem to show a cycle of 48 years. Still longer cycles are suggested by the rings of growth of trees, but these fall beyond the scope of the present conference. So far as the length of cycles is concerned the results may be summed up as follows: There is fairly abundant evidence as to a four-year cycle, the length of which seems to be almost exactly four years. A cycle

of six years is suggested but not confirmed. A cycle of between nine and ten years, on the other hand, is very strongly indicated. It is often called a ten-year cycle, but the most accurate determinations suggest that the true length is nearer nine and one-half years. A cycle of perhaps 18.6 years appears to be at least as widespread and definite as the four-year cycle. As to the larger cycles no data for gauging their importance were forthcoming at the conference.

The causes of cycles in animals appeared to the conference to be divided into three groups: biological, meteorological and astronomical. The first includes food, reproduction, parasitic insects and diseases, especially those of bacterial origin; the second, or meteorological group, needs no definition; the third group may be briefly discussed before we turn to the others. It was dealt with chiefly by Mr. DeLury. He holds that the chief causes of climatic variation are partly solar and partly lunar. The conference seemed to feel that while terrestrial climatic fluctuations are probably due to solar variations, such fluctuations are probably due to other astronomical causes as well as to the variations which manifest themselves as sunspots. One of the strongest impressions of the whole conference was that all sorts of cyclic phenomena must be controlled, though not necessarily caused, by some outside forces which dominate all forms of life. If these are solar forces, they manifest themselves as sunspots, prominences, faculae, the solar constant, electro-magnetic activity and perhaps still other phenomena. These presumably lead to both meteorological and organic phenomena on the earth. If lunar forces have any effect in producing cycles, they presumably act through the tides, which in turn give rise to oceanic currents and upheavals of cold water from below. These are supposed to alter the atmospheric pressure and thus cause winds, storms, rain and changes of temperature.

No one at the conference seemed to entertain much doubt that migrations of animals and variations in their numbers are often due to the food supply. Some of the most clear-cut examples are the migrations of the snowy owls when the supply of mice runs short after a period of great abundance. It is almost equally clear that the extraordinary variations in the numbers of rabbits, muskrats and other rodents from one extreme of the ten-year cycle to the other are one of the main causes for variations in the numbers of foxes, lynxes, mink and other fur-bearing animals. Mr. Elton's curves showing the numbers of skins of such animals brought in to the Hudson's Bay Company posts give good indication that the ups and downs of the furbearers follow closely on those of their prey, although the maximum number of the furs of carnivores is brought into the market a year after the maximum of rabbits. It was also made clear by various members of the conference that sea animals wander about in huge numbers in response to variations in their food supply. One of the most interesting of such wanderings is the migration of the sperm whales described by Dr. Charles Townsend of the New York Aquarium. The small crustaceans and other minute forms of life upon which these huge animals feed are abundant only in summer. Therefore, in order to obtain the barrels and barrels of food which form their meals, the whales each year wander back and forth over routes six to eight thousand miles long. During our summer they are in the northern hemisphere, and during the southern summer in the southern hemisphere.

Such annual migrations, however, were only an incidental feature of the discussions. The main interest in the wanderings of animals centered around those which recur at longer intervals. These generally represent great changes in the total number of living animals. But the fish of the sea, as Dr. Harry M. Kyle, of Glasgow, pointed out, show different phenomena from the animals of the land in this respect. Their numbers may vary enormously, but the fact that the fishermen do not catch the normal quantity of fish in any given year does not necessarily mean that there are fewer fish than usual in the sea. The ocean is so huge that the best food supply, or the best spawning grounds, may lead the fish to concentrate in parts of the ocean where there is commonly little fishing. Consequently the various conditions under which the fishermen do their work must be taken into account as well as the variable causes affecting the number of fish that hatch and survive. In other words, the optimum years for the fisheries are by no means necessarily the optimum years for the fish.

In spite of the importance of the food supply there appeared to be a strong feeling that other causes of variations in the numbers of animals deserve more attention than is commonly given them. One such cause is the rate of reproduction. Mr. Elton stated that the number of young snowshoe rabbits and other animals born in the average litter apparently tends to increase in certain years and to decrease when scarcity of food and other causes lead to a reduction in the number of animals. Dr. Huntington showed that even in man the rate of reproduction is very closely correlated with climatic conditions. A rapidly increasing race like the Japanese would decline in numbers if the relative rates of deaths and of conceptions resulting in living births stayed steadily at the levels of September when health and vigor are at a minimum. Professor Rowan presented experimental evidence suggesting that the same thing is true among birds. By altering the conditions of light and

temperature he has induced birds to breed in midwinter. Dr. Kyle and Prof. Huntsman made it clear that reproduction in fish and other sea animals responds with equal readiness to changes in temperature.

One of the facts which the layman is only beginning to realize is the enormous number of parasitic worms and insects which infest most forms of animals, as well as plants. The importance of this in plants was explained by Dr. Eidmann in respect to the forests of Germany. He believes that the growth of trees is influenced quite as much by insects as by the climatic factors of temperature and rainfall. The insects themselves, however, are very closely dependent upon these same climatic factors. Thus the rate of growth of the trees is the composite result of the effect of climate upon the tree itself plus its effect upon the insects. Dr. Gross illustrated the same thing in respect to animals by means of the parasitic insects and worms which infest the organs of the grouse. Professor Rowan showed how the reverse effect is obtained by removing ticks or other infestations and allowing an infested animal to regain its strength.

In the production of cycles among animals an even greater part seems to be played by bacterial parasites and the diseases to which they lead than by the larger parasites. This was especially well illustrated by Professor R. G. Green, of the University of Minnesota, in his discussion of tularaemia, a disease of rabbits and grouse. He demonstrated clearly that during the last rabbit cycle in Minnesota the "crash" when the animals suddenly died off was due to a very virulent form of this bacterial disease. The disease is carried by ticks, which also infest grouse. Professor Green's findings have resulted in the theory that when the rabbit population begins to decline the tularaemia bacteria are extremely virulent, while the proportion of old and immune rabbits is very small. Hence millions of rabbits die, for the mortality is almost one hundred per cent. The ticks which they carry fall to the ground, but soon find new hosts in other rabbits and grouse, thus spreading the disease. For some unknown reason, however, the virulence of the tularaemia bacteria decreases rapidly. After the epidemic it becomes so low that as young are born from the surviving rabbits they do not die from the disease, but have a non-fatal form of the disease which makes them immune. Thus there arises a group of immune rabbits, some of which survive the next epidemic and carry on the race.

Another epizootic disease which received considerable attention was encephalitis in dogs, foxes and other fur-bearing animals. This disease, as was shown by Messrs. Green, Elton and Anderson, behaves somewhat like rabies, except that the affected animals do not bite. Here, unlike the case of tularaemia, we have a disease in which the resistance of the animal has a great effect in determining the occurrence and virulence of the disease. In tularaemia the parasitic bacteria are so virulent at the time of their main onset that practically all affected animals die no matter how strong they may have been. Such facts as this precipitated a lively discussion as to the relative importance of changes in the virulence of the parasites compared with changes in the degree of resistance of the host. The conclusion seems to be that there is no general rule. Under certain conditions and with certain diseases the power of a disease varies in close harmony with the general health of the animals which it attacks. Under other circumstances a more virulent parasite may be so strong that no animal can resist it. But all organisms from bacterial parasites to whales appear to pass through cycles of strength and weakness arising from the combined effects of food, conditions of reproduction, parasites and the immediate climatic environment.

The features of the climatic environment most frequently discussed at Matamek were naturally temperature and rainfall. Throughout the conference it was universally recognized that all forms of life have certain limits of temperature, and that between these limits lies an optimum or most favorable condition. According to Dr. Huntington this optimum in man varies not only with the age of the individual, but also from one function to another. Thus physical and mental activity have different optima of temperature. The optimum for reproduction may be still different, as was shown by Dr. Kyle and others. Rainfall was not much discussed, although its importance was frequently recognized in discussing the food supply.

Three other atmospheric conditions were also brought to the attention of the conference. One of these was ultra-violet light which was discussed mainly by Mr. DeLury and Professor Rowan. The latter explained to the conference certain very interesting experiments now in progress which seem to show that the effect of ultra-violet light upon reproduction in birds is striking.

On the basis of an extensive study of deaths Dr. Huntington presented evidence concerning the effect of the relative humidity of the atmosphere upon human health and activity. He also pointed out that variability of temperature in itself has an important effect apart from that of the actual temperature. In New York City, for example, a moderate degree of variability from one day to the next is distinctly the best condition. Very high variability, to be sure, is not so conducive to health as is moderate variability,

but very low variability is still worse. In other words a climate with frequent storms of moderate severity is more healthful than one with uniform weather all the time. The conference seemed to feel that both relative humidity and variability of temperature are factors whose weight has not been fully recognized by biologists. Dr. Eidmann sustained this view by showing that among insects the effects of relative humidity and variability are almost the same as among men. In fact one of the outstanding features of the conference was the frequency with which one member or another emphasized the fact that in spite of minor differences the general reactions of men, animals and even plants to physical environment are essentially the same. Certain great laws seem to run all the way through the whole realm of life, and one result of the working of these laws is that cycles are very wide-spread phenomena.

The phenomena discussed by the conference included not only cycles due to external causes, but those of a purely biological nature. Thus Dr. Belding called special attention to the variable life history of the salmon with its river stage, oceanic stage and final stage of return to the rivers for spawning. The chief problem here is why the salmon vary in size, in age and in the length of their life cycle from one region to another and even from one river to its neighbor only a few miles away. Similar local and inexplicable variations are found in wholly different types of life such as the ticks described by Dr. Green. On one side of the Bitter Root River, ticks carry a highly virulent disease, while on the other side their virulence is far lower. When ticks are carried from one side of the river to the other they soon acquire the virulence characteristic of that side, no matter what may have been their previous condition.

The abundance of the cod, a truly oceanic fish, was shown by Dr. Kyle to follow laws which at first sight seem quite different from those governing the cycles so common in other creatures. Since each female cod lays from one to five million eggs per year the danger of exterminating the species or even diminishing it by fishing seems to be negligible. One of the most important features of certain fisheries, *e.g.*, herring and plaice, is that the animals are most abundant in the waters which have been most fully fished. Thus herring have been taken from the North Sea abundantly for 1,200 years. Yet to-day they are as abundant as ever, and perhaps more so. Dr. Kyle's explanation is that the fishing removes the old fish which consume much food, but nevertheless grow slowly. Where the fish are young, a given supply of food produces a maximum amount of growth and thus a maximum supply of food for man. From this standpoint fishing is like agriculture; that is, human activity leads to an optimum condition for man by reason of the rapid growth of the fish. Prof. J. R. Dymond, of the University of Toronto, stated that the same rule applies in the case of several fresh water fishes.

A general review of the mammals of the world, by Mr. H. E. Anthony, of the American Museum of Natural History of New York, illustrates some of the main conclusions of the conference as to the distribution of cycles. In a broad way the land mammals of the earth are at a minimum in the great tropical forests. There, too, so far as our present information goes, such animals are least subject to cycles. This may be because of the general scarcity of mammals in those areas, and also because the environment is so uniform that there is apparently little reason for great changes in numbers. Outside of such forests lie tropical regions where there is more grass and smaller trees. There the mammals increase greatly in numbers and we have such areas as the famous game regions of Africa. In such areas the number of animals is often incredibly large. As yet we have no definite evidence as to whether the fluctuation in numbers is correspondingly great, even though the variations from wet seasons to dry are extreme. In higher latitudes, as has already been implied, there are likewise certain rather steady areas such as the eastern United States where many animals live under conditions which approach the optimum and where extremely harmful variations in climate are comparatively rare. Thus in such regions the cycles in animal numbers are mild. In the marginal regions, however, such as the drier and colder parts of the continents, it requires only a slight departure of the climate from its normal condition to produce great changes in the food supply and in the conditions of reproduction and bacterial infection. Thus in those regions animals increase enormously at certain times and then decline with a crash. The same contrast between areas of relative uniformity and variability is perhaps seen in the cod, plaice and salmon. The cod and plaice, even though the fishermen can not find them, appear to be numerous at all times and may suffer relatively little from cyclic variations in numbers. This may be because they inhabit a relatively uniform region where the temperature and food supply vary but little. The salmon, on the contrary, because of its habit of coming to the rivers to spawn, occupies a marginal area. Not only is it subject to great variations in most of the conditions which control its numbers, but when the smolt pass from fresh water to the salt sea, they are subject to an environmental change unknown to the purely marine fish.

The conference closed with a general session on

conservation and allied topics. Mr. D. R. Cameron added new strength to what he had previously said as to the importance of forest fires. Dr. Harrison F. Lewis, of the National Parks Branch at Ottawa, told about the Canadian game sanctuaries. Dr. Anderson drew attention to the importance of museum collections as a factor in cooperative field studies upon wild animals. It is useless to make observations upon wild animals if the species that is studied is not properly identified. The conference as a whole was strongly in favor of intelligent conservation. It was pointed out, however, that in some cases our conservation measures go so far that they defeat their own ends, as when deer ruin gardens or die for lack of food, or big fish eat the food that ought to be left for rapidly growing young fish, an eventuality unlikely to arise in the case of land animals. In other words, conservation, like almost everything else, has an optimum. Until the optimum is reached it is highly desirable, but beyond that it goes too far.

OBITUARY

CALVIN HENRY KAUFFMAN

CALVIN HENRY KAUFFMAN died at Ann Arbor, Michigan, on June 14, 1931, following a stroke of paralysis that occurred in February, 1930. He was born on March 10, 1869, near Lebanon, Pennsylvania, and received his preparatory training in a country school near Lebanon and at Palatinate College, Myerstown, Pennsylvania. In 1896 he graduated from Harvard University with the A.B. degree, specializing in Greek and Latin. From 1896 to 1898 he was principal of a preparatory school at Lebanon, Pennsylvania. He taught in a high school at Decatur, Indiana, from 1898 to 1900 and at Bushnell College, Bushnell, Illinois, from 1900 to 1901.

In 1901 he decided to take advanced training in science at the University of Wisconsin, specializing in chemistry and botany. Here he came under the influence of Professor R. A. Harper, who was responsible for definitely directing his interest in the field of mycology. The following two years (1902 to 1904) were spent as an assistant and graduate student with Professor G. F. Atkinson at Cornell University. Under Atkinson's influence his interest in the agarics was stimulated and developed. In 1904 he was appointed an instructor in the botany department at the University of Michigan, where he continued his graduate studies, stressing the physiological phases, receiving his Ph.D. degree in 1907, with a doctorate dissertation entitled "A Contribution to the Physiology of the Saprolegniaceae with Special Reference to the Variations of the Sexual Organs."[1]

The rest of his life was spent at the University of Michigan, where he developed courses and directed research in algae, mosses and ferns, mycology and forest pathology. He was advanced to the rank of assistant professor in 1912 and associate professor in 1920. In 1921 he was made director of the University Herbarium and in 1923 became professor of botany. From 1917 to 1919 he was on leave from the University of Michigan for the purpose of serving as pathological inspector with the Federal Horticultural Board of the United States Department of Agriculture. He was a fellow of the American Association for the Advancement of Science and a member of the American Botanical Society, Torrey Botanical Club, Société Linnéenne de Lyon, Washington Botanical Society, Michigan Academy of Science, Arts and Letters, Sigma Xi and the American Forestry Association.

Dr. Kauffman was outstanding both as an investigator and teacher. His interest in the agarics resulted in numerous papers concerning the taxonomy of various genera, especially Cortinarius, Inocybe, Lepiota, Clitocybe, Gomphidius and Armillaria. His "Agaricaceae of Michigan"[2] serves not only as an exhaustive and critical treatment of the agarics of Michigan but as a standard reference for the species described. In addition he published papers concerning various species of Phycomycetes, Gasteromycetes, Thelephoraceae and Polyporaceae as well as numerous mycological floras of Michigan and other states. He had a broad knowledge of the fungi of the United States gained from many summers spent in the field collecting in Michigan, New York, Pennsylvania, Maryland, Virginia, Kentucky, Tennessee, Montana, Colorado, Wyoming, Idaho, Oregon and Washington. He also contributed publications in the field of plant pathology, especially concerning the rots and mycorrhizas of trees. His broad interests have been reflected in the choice of subjects for investigation by his students who have been guided by him in studies concerning algae, bryophytes, ferns and among fungi have studied problems in all the major groups. He never lost his early interest and enthusiasm in teaching. His students will always remember him for the example which he set by his untiring enthusiasm in research and for the inspiring criticism and encouragement which he always freely gave.

E. B. MAINS

UNIVERSITY OF MICHIGAN

[1] *Ann. Bot.* 22: 361–387, 1908.

[2] *Mich. Biol. Geol. Surv.* 26: Biol. Ser. 5, 1918.

MEMORIALS

WE learn from the *New York Times* that in commemoration of the hundredth anniversary of the death of the great French astronomer and mathematician, Pierre Simon de Laplace, which occurred in 1927, a memorial monument will be erected in the town of Beaumont, France, where he was born. It will be of bronze on a granite pedestal. The statue will probably be exhibited in the next Paris Salon and dedicated some time during the summer of 1932.

Nature reports that on July 28 a memorial tablet to Thomas Earnshaw, the horologist, was unveiled outside the Church of St. Giles-in-the-Fields, Bloomsbury, by the Astronomer Royal, Sir Frank Dyson. The tablet has been erected by the Clockmakers' Company and the British Horological Institute. Like his predecessors, Graham and Harrison, and his contemporaries, Mudge and Arnold, Earnshaw came from the country, having been born at Ashton-under-Lyne, Lancashire, on February 4, 1749, but for many years he had a business at 119 High Holborn. To him is ascribed the merit of devising the chronometer escapement and compensation balance precisely as they are now used, while it was he and Arnold who first produced chronometers in large numbers and at moderate cost, thus rendering service of the utmost value to navigation and commerce. His improvements were recognized by the commissioners of longitude, and he was awarded £3,000 by the government. His death took place in Chenies Street, Bedford Square, on March 1, 1829, and he was buried in St. Giles-in-the-Fields, where it was his custom to worship. He had published a pamphlet in 1806 entitled "Explanation of Timekeepers constructed by the Author and the late Mr. John Arnold," and another in 1808 stating his own claims to the invention of improvements in timekeepers.

RECENT DEATHS

DR. C. L. BRISTOL, emeritus professor of biology at New York University, died on August 27 at the age of seventy-two years.

DR. JAMES T. PORTER, head of the department of physics at the University of Tennessee and assistant dean, died on August 27. Dr. Porter was fifty-seven years of age.

DR. WILLIAM PARKER BOOKE, professor emeritus of preventive dentistry and oral hygiene at Harvard University, died on August 25 at the age of seventy-two years.

DR. ARCHIE H. KIRKLAND, consulting economic entomologist, died on September 29, at the age of fifty-eight years.

DR. GEORGE G. BROWNELL, whose work has been the culture of citrus fruit in connection with the U. S. Department of Agriculture, died on August 28 at the age of sixty-two years.

SCIENTIFIC EVENTS

THE MEETING OF THE BRITISH ASSOCIATION

FROM September 23 to 30 the Centenary meeting of the British Association meets in London for the first time in its history. The reception room of the Imperial Institute at the University of London will be open on Tuesday, September 22.

General Smuts will assume the presidency in succession to Professor F. O. Bower in the Albert Hall on Wednesday, September 23, and will receive the invited delegates of societies and institutions, and of universities, colleges and cities in which the association has held meetings in the past. On the evening of the same day General Smuts will deliver his presidential address, of which the subject is "The Scientific World Picture of To-day," in the Central Hall, Westminster. The address will be relayed to other halls and will be broadcast. The work of the sections of the association will begin on September 24 and will be continued until September 30.

The presidential addresses in the sections are to be spread over several days and include the following: Section A (Mathematical and Physical Science), Sir J. J. Thomson on "The Growth in Opportunities for Education and Research in Physics in the Past Fifty Years"; Section B (Chemistry), Brigadier-General Sir Harold Hartley on "Michael Faraday and the Theory of Electrolytic Conduction"; Section C (Geology), Professor J. W. Gregory; Section D (Zoology), Professor E. B. Poulton, F.R.S., on "A Hundred Years of Evolution"; Section E (Geography), Sir Halford J. Mackinder on "The Human Habitat"; Section F (Economic Science and Statistics), Professor E. Cannan on "Internationalism in Economic Theory"; Section G (Engineering), Sir Alfred Ewing on "Power"; Section H (Anthropology), Professor A. R. Radcliffe-Brown; Section I (Physiology), Dr. H. H. Dale on "The Biological Nature of Filtrable Viruses"; Section J (Psychology), Dr. C. S. Myers on "The Nature of Mind"; Section K (Botany), Professor T. G. Hill on "The Advancement of Botany"; Section L (Educational Science), Sir Charles Grant Robertson on "Educational Theory, 1831 and 1931"; Section M (Agriculture), Sir John Russell on "The Changing Outlook in Agriculture."

Evening discourses are to be given by Professor W.

A. Bone on "The Photographic Analysis of Explosion Flames," Sir Peter Chalmers Mitchell on "Zoos and National Parks," Sir Arthur Keith on "The Construction of Man's Family Tree," Sir Oliver Lodge on "A Retrospect of Wireless Communications," Sir James Jeans on "Beyond the Milky Way," and Dr. S. Kemp on "Oceanography in the Antarctic."

A public lecture, non-members included, will be given by Mr. Angus Macrae on "Guidance in the Choice of an Occupation," at 3:30 P. M. on Monday, September 28, in the London School of Economics. Other public lectures will be arranged in several of the polytechnic institutions.

Receptions will be given as follows: At the National Physical Laboratory, Teddington, in connection with the visit on Thursday afternoon, September 24; at Bedford College for Women, Regent's Park, N.W.1, on Thursday afternoon, September 24, from 4 to 6 P. M.; by the Royal Society to invited delegates, in connection with the Faraday Centenary Celebration, on Thursday evening, September 24; by H. M. Government in the Imperial Institute on Friday evening, September 25, beginning at 9 P. M.; by the founder and director of the Wellcome Historical Medical Museum on Friday evening, September 25, beginning at 8:30 P. M.; at the Hampton Court Palace on Saturday afternoon, September 26; in the Court and the Senate of the University of London and at the Wellcome Historical Medical Museum on Monday evening, September 28; at the Forum Women's Club, on Tuesday afternoon, September 29; by the Right Honorable the Lord Mayor and Corporation of the City of London, on Wednesday evening, September 30, at Guildhall.

The reception of members has also been arranged in connection with many other excursions and visits.

An invited party will visit York, the birthplace of the association, on Saturday and Sunday, September 26 and 27. Down House, the home of Darwin, now held by the association in custody for the nation, will be open to members throughout the meeting.

Interesting exhibits of importance have been arranged at various institutions during the meetings.

THE INTERNATIONAL CONVENTION OF THE ELECTROCHEMICAL SOCIETY

PROFESSOR JOHN A. FULTON, director of the Mackay School of Mines, Reno, Nevada, invited authorities on silver to present their views at a luncheon and round table discussion, held at the Hotel Utah, on Thursday, September 3, in connection with the international convention of the Electrochemical Society meeting from September 2 to 5 in Salt Lake City. The state of Utah is the largest silver-producing state in the union, furnishing over 25 per cent. of the total production in the United States. Mining, metallurgy and the utilization of silver were carefully considered.

On Wednesday, September 2, an entire session was devoted to cyanides in metallurgy, which has an important bearing on the gold situation. Due to many improvements made in the cyanide process, gold can to-day be recovered from ores which were formerly considered worthless. Dr. Dorsey A. Lyon, of the University of Utah, presided.

A session on miscellaneous electrochemical papers took place on Thursday, September 3. Professor Jean Billiter, of the University of Vienna, Austria, described his new electrical apparatus for the purification of drinking water. Dr. M. Sem, of Oslo, Norway, presented data on the new Soderberg electrode. This electrode is from four to five feet in diameter and has been used with success in the production of carbide. Mr. W. E. Moore, well-known furnace expert of Pittsburgh, reported on the latest developments in electric furnace design.

The Edward Goodrich Acheson Medal was presented to Dr. Edwin Fitch Northrup, vice-president of the Electrothermic Corporation, of Trenton, New Jersey, on September 3. An award of $1,000 in cash accompanies the medal. Dr. Northrup is well known for his work in electric furnace design. After the award of the medal, Dr. Northrup addressed the members and guests on "What is Electricity?"

Flotation, the process by which valuable metals in any ore can be readily and cheaply segregated, is the subject of the symposium, to be held on Saturday, September 5. Professor A. M. Gaudin, of the Montana School of Mines, will preside. This metallurgical process was invented by Miss Carrie J. Everson, of Denver, Colorado. The introduction of flotation has completely revolutionized mining and metallurgy within the last ten years. Among those who will participate in the symposium are Professor Herbert Freundlich, of Berlin; Dr. Oliver C. Ralston, of the United Verde Copper Company; Dr. Edmund S. Leaver, of the U. S. Bureau of Mines, and four engineers of the American Cyanamid Company.

THE AWARD OF THE PRIZE OF THE RESEARCH CORPORATION

DR. ANDREW ELLICOTT DOUGLASS has received the $2,500 prize of the Research Corporation through the Smithsonian Institution for his work in establishing the date of the construction of Pueblo Bonito in Northern Mexico by the measurement of tree rings. The field work was done on the pre-Columbian Beam Research Expedition of the National Geographic Society of which Dr. Douglass was leader.

In the report of his work to the National Geographic Society Dr. Douglass wrote:

By translating the story told by tree rings we have pushed back the horizons of history in the United States for nearly eight centuries before Columbus reached the shores of the New World, and we have established in our Southwest a chronology for that period more accurate than if human hands had written down the major events as they occurred.

We are now able definitely to announce the important dates in the history of Pueblo Bonito, oldest and largest of the great Indian communities, in Chaco Canyon, New Mexico.

Furthermore, we can now date nearly forty prehistoric ruins in the Southwest and reconstruct there a succession of major events through which Indian settlements rose, passed their heyday and disappeared.

Just as the far-famed Rosetta Stone provided the key to the written mysteries of ancient Egypt, so the collection of an unbroken series of tree rings has made clear the chronology of the Southwest.

Through this work we have learned of some outstanding events in America which were contemporaneous with the conquest of Spain by the Moors, and we know that certain Pueblo Indian settlements were enjoying their golden ages when William the Conqueror faced Harold the Saxon at the battle of Hastings.

These researches have carried the calendar back to A. D. 700 in the Southwest, and they have provided the beginnings of a continuous weather chart for 1,200 years.

The earliest beam we recovered from Pueblo Bonito was cut A. D. 919 from a tree that was 219 years old when cut. Pueblo Bonito had reached its golden age in 1067 and was still occupied in 1127.

The method which we have used in extending the historical calendar of the Southwest is the outcome of a long attempt to read the diaries of trees. Every year the trees in our forests show the swing of time's pendulum and put down a mark. They are chronographs, recording clocks, by which the succeeding seasons are set down through definite imprints. Every year each pine adds a layer of new wood over its entire living surface of trunk and branches.

If every year were exactly the same, growth rings would tell the age of the tree and little more. Only in rare cases would they record exceptional events of any interest to us.

But a tree is not a mechanical robot; it is a living thing, and its food supply and adventures through life all enter into its diary. A flash of lightning, a forest fire, insect pests or a falling neighbor may make strong impressions on its life and go into its diary.

But in the arid regions of our Southwest, where trees are few and other vegetation scarce, the most important thing to man and trees is rainfall. This fact has helped vastly in our dating work, for certain sequences of years become easily recognized from tree to tree, county to county, even from state to state.

THE PROPOSED SURGICAL BUILDING FOR YALE UNIVERSITY

A FUND of $1,100,000 for a surgical building for Yale University at the New Haven Hospital is provided by the bequest of Mrs. Sarah Wey Tompkins, whose father, Dr. William C. Wey, served the community of Elmira, New York, for half a century as a leading physician and surgeon. Mrs. Tompkins during her lifetime gave to the university the tract of land near the Yale Bowl, now known as the Ray Tompkins Memorial, in memory of her husband. In her will, she made a bequest to Yale which has proved sufficient to enable the university now to proceed in accordance with the wishes expressed by the donor prior to her death. Work on the new building, to be known as the Sarah Wey Tompkins Memorial, will soon be begun.

The erection of this unit brings near to completion the modernization of the entire physical plant of the New Haven Hospital, in accordance with a plan adopted five years ago. Three sections of the hospital must still be provided. These are the pavilion for contagious diseases, an addition to the private pavilion for persons of moderate means and a women's pavilion. The completed plant will then represent an investment of $8,000,000 in buildings, of which approximately $6,500,000 has now been obtained.

The new building will have five hospital floors, and a ground floor for "out-patient," or dispensary, service. On the ground floor will be the examining and treatment rooms for surgery, including orthopedics, urology, physical therapy and accident and emergency units. The first floor will have 27 beds for male surgical patients; the second floor, 27 beds for women requiring general surgical treatment; the third floor, 24 beds for gynecological patients; the fourth floor, a nursery and 20 beds for obstetrical cases, and the fifth floor, 27 beds for eye, ear, nose and throat cases.

Each of the ward floors will have a treatment room, diet kitchen, doctors' room, nurses' room, solarium and open air balconies, and will thus have practically all facilities required for a hospital, with the exception of operating rooms, which have been placed in the Farnam building adjoining. There will be twelve single-bed rooms on each floor, one eight-bed room, and several two-bed and three-bed rooms.

Staff members in the department of surgery and the department of obstetrics and gynecology have their offices and research and teaching facilities in the Farnam Memorial Building, to which the new surgical pavilion will be connected on every level. Similar facilities for members of the department of internal medicine are provided in the new medical and pediatric laboratory building, with which the Raleigh Fitkin Memorial Pavilion and the proposed pavilion for infectious diseases will be connected. This arrangement will bring all the required facilities close together.

When the three new units still needed in order to complete the hospital have been provided, there will be about 440 ward beds for those who can not pay the full cost of hospital care and about 160 beds for patients who can meet this cost.

THERAPEUTIC TRIALS COMMITTEE OF THE BRITISH MEDICAL RESEARCH COUNCIL

ACCORDING to the London *Times*, the British Medical Research Council announce that they have appointed a Therapeutic Trials Committee, as follows, to advise and assist them in arranging for properly controlled clinical tests of new products that seem likely, on experimental grounds, to have value in the treatment of disease:

Professor T. R. Elliott, physician to University College Hospital, London, *chairman*.
Sir E. Farquhar Buzzard, regius professor of physics, University of Oxford.
Dr. H. H. Dale, director, National Institute for Medical Research.
The Right Honorable Lord Dawson of Penn, president, Royal College of Physicians, London.
Professor A. W. M. Ellis, physician to the London Hospital.
Professor F. R. Fraser, physician to St. Bartholomew's Hospital, London.
Sir John Parsons, ophthalmic surgeon to University College Hospital, London.
J. A. Ryle, physician to Guy's Hospital, London.
Sir John W. Thomson-Walker, consultant urologist to King's College Hospital, London.
Wilfred Trotter, surgeon to University College Hospital, London.
Professor D. P. D. Wilkie, surgeon to the Royal Infirmary, Edinburgh.
F. H. K. Green, *secretary*.

Conditions have been the subject of discussion and agreement between the Medical Research Council and the Association of British Chemical Manufacturers, under which the Therapeutic Trials Committee will be prepared to consider applications by commercial firms for the examination of new products, submitted with the available experimental evidence of their value, and will arrange appropriate clinical trials in suitable cases. The committee will work in close touch also with the existing Chemotherapy Committee, who are engaged for the Medical Research Council in promoting researches aimed at the discovery and production of new remedies.

The Therapeutic Trials Committee will invite suitable experts in particular branches of medicine or surgery to undertake the clinical tests of preparations accepted for trial. The reports upon the results will be published under the authority of the committee.

SCIENTIFIC NOTES AND NEWS

DR. ROBERT A. MILLIKAN, of the California Institute of Technology, has been made Knight of the Legion of Honor by the French Government.

PROFESSOR RUFUS H. PETTIT, head of the department of entomology at Michigan State College, received the honorary degree of doctor of science at the commencement exercises at the college, in recognition of his high attainments as an investigator and teacher and of "his thirty-four years of loyal and efficient service."

DR. M. LUCKIESH and Frank K. Moss, of the Nela Research Laboratory of the General Electric Company, Cleveland, have been awarded the gold medal of the Distinguished Service Foundations of Optometry.

IT is announced in the *British Medical Journal* that a fund is being inaugurated in order that the friends, colleagues and pupils of Colonel Thomas Sinclair, emeritus professor of surgery in Queen's University, Belfast, may have an opportunity to express their appreciation of his invaluable services to the Belfast Medical School. Professor Sinclair occupied the chair of surgery from 1886 to 1923. The testimonial will probably take the form of a portrait to be painted and presented to the university.

PROFESSOR ARIENS KAPPERS, director of the Central Institute for Brain Research, Amsterdam, recently received the honorary degree of doctor of science from the University of Dublin. Professor Kappers delivered three lectures on diseases of the brain while in Dublin.

DR. BERNHARD FISCHER, professor of pathology at Frankfurt, has been elected an honorary member of the Royal Institute of Public Health, London.

DR. VICTOR MORITZ GOLDSCHMIDT, of Göttingen, has been elected a corresponding member of the Geological Society at Stockholm and a foreign member of the Geological Society of London.

M. JACOB, professor of geology at the Sorbonne, has been elected a member of the French Academy of Sciences.

COLONEL CHAS. F. CRAIG, director of the department of preventive medicine and clinical pathology at

the Army Medical School, has been appointed professor of tropical medicine and director of the department at Tulane University Medical School.

PROMOTIONS to full professor at New York University are as follows: Professors Elmer G. Hooper, hydraulics; C. Theodore Schwarze, civil engineering; Newman L. Hoopingarner, business psychology, and Ira Kaplan, clinical professor of surgery. Promotions to associate professor are: Dr. W. H. Crew, physics; Professors Otto Halpern, physics, and David Porter, industrial engineering. Promotions to assistant professor are: Professors C. T. Chase, physics, and Donald Flanders, mathematics. New appointments are as follows: T. A. Jackson, visiting assistant professor of psychology, and A. C. G. Mitchell, assistant professor of physics. At Washington Square College promotions to assistant professor were Professors Harry A. Charipper, biology, and Francis Holden, psychology. T. C. Schneirla has been appointed assistant professor of psychology.

DR. JOSEPH L. JOHNSON, of Philadelphia, has been appointed head of the department of physiology in the School of Medicine of Howard University.

DR. J. J. DURRETT, chief of Drug Control, Federal Food and Drug Administration, has tendered his resignation. Dr. Durrett will be succeeded by Dr. Frederick J. Cullen, chief medical officer of the administration.

DR. JOHN D. BLACK, professor of economics at Harvard University, has been appointed chief economist of the Federal Farm Board. He will devote only part of his time to this work and will continue as usual at Harvard University. Dr. Black succeeds Dr. Joseph S. Davis, who has been on leave of absence from Stanford University and who will return there as a director of the Food Research Institute. The Farm Board also has announced the appointment of Dr. M. J. B. Ezekiel and G. C. Haas as assistants to Dr. Black.

DR. A. K. PARPART, who received his doctor's degree from the University of Pennsylvania this spring, has accepted an appointment as instructor in the department of physiology at Princeton University.

PROFESSOR JAMES GARFIELD HALPIN, head of the poultry department at the Wisconsin College of Agriculture, was elected president of the National Poultry Science Association at its annual meeting recently held at the University of Kentucky. Other officers chosen for the coming year are: Dr. Fred Hutt, of the University of Minnesota, *first vice-president;* Professor Duncan H. Reid, of the Texas Agricultural and Mechanical College, *second vice-president,* and W. A. Maw, Macdonald College, Canada, *secretary.* The 1932 meeting will be held at Massachusetts State College.

A MICROSCOPE was presented to Professor Ludwig Aschoff, of Freiburg in Breisgau, Germany, who has worked primarily in the field of pathology and anatomy, by the Optical Works of E. Leitz, in Wetzlar, Germany, after having completed their 300,000th microscope. The dedication of this microscope follows a custom of the firm of E. Leitz to present every 50,000th microscope to an outstanding scientific man or institute. The names of the institutions and scientific men who have received the 50,000th microscopes are as follows: German Tuberculosis Sanitarium in Davos, Switzerland; Dr. Robert Koch, of Berlin; Dr. Paul Ehrlich, of Frankfurt; Dr. Martin Heidesheim, of Tübingen; the Institute for Tropical Hygiene in Hamburg, and Dr. Ludwig Aschoff, of Freiburg in Briesgau.

MR. ERNEST H. VOLWILER has been elected president of the Chicago Chemists Club. Other officers were elected as follows: Bruce K. Broun, *first vice-president;* Walter J. Bently, *second vice-president;* Louis Ehrenfeld, *treasurer,* and Charles D. Lowry, Jr., *secretary.*

DR. WILBUR K. BUTTS, assistant professor of biology at James Millikin University, will replace Dr. Wyman R. Green as head of the department of biology at the University of Chattanooga. Dr. Green will direct the department of biology of Drew University.

MR. HUGH M. WOLFIN has been appointed supervising engineer of the Intermountain Experiment Station of the U. S. Bureau of Mines at Salt Lake City, Utah.

MR. F. N. MOWDAWALLA has been appointed professor of electrical technology in the Indian Institute of Science, Bangalore. Mr. Mowdawalla has succeeded Professor J. K. Catterson-Smith.

MR. SAMUEL LEES has been appointed to the Chance chair of mechanical engineering at the University of Birmingham, England, in succession to Professor F. W. Burstall.

DR. THOMAS FOTHERINGHAM MACRAE has been appointed to a research studentship in biochemistry at the Lister Institute.

DR. J. MCKEEN CATTELL, editor of SCIENCE, sailed for England on August 26 in order to attend as the delegate of the American Association for the Advancement of Science the centenary meeting of the British Association.

DR. DOUGLAS JOHNSON, professor of physiography

at Columbia University, has sailed for Paris on the North German Lloyd liner *Berlin*, as a delegate to the International Geographic Congress.

DR. H. J. GERSTENBERGER, professor of pediatrics in the School of Medicine of Western Reserve University, Cleveland, has gone to Europe to address the German Pediatric Society meeting in Dresden in September.

DR. CHARLES H. HERTY, adviser to the Chemical Foundation of New York, has been appointed to direct a pine pulp mill, where he will experiment on the manufacture of newsprint, to be established in Georgia in January, 1932, with the cooperation of the newly created Department of Forestry and Geological Development of Georgia. The Chemical Foundation has donated $50,000 to match the $20,000 appropriation made recently by the Georgia Legislature for the mill. For several years Dr. Herty has experimented in making paper from pine.

DR. LUDWIG WEICKMANN, director of the Geophysical Institute of Leipzig, will conduct experiments in the temperature of trade winds in the *Graf Zeppelin* with a miniature airship trailed from the dirigible on a cable. The *Graf Zeppelin* will fly over France, Spain and the Canary Islands.

ACCORDING to the London *Times*, Professor Auguste Piccard has decided to make a second ascent by balloon before presenting the report on his recent ascent into the stratosphere to the Belgian Fonds National de Récherche Scientifique. In this second ascent he will not go higher than 4,000 or 5,000 meters (13,000 to 16,000 feet). His object will be to verify certain observations that he made in the stratosphere.

THE geology car from Princeton University, which, under the direction of Professor Richard Montgomery Field, has carried twenty-seven professors and students through Jasper Park to Vancouver, B. C., and finally to Red Lodge, Montana, for study of rock formations, returned to Princeton on August 26. Dr. Kenneth H. Condit and Mr. Erling Dorf, of the university faculty, were members of the party.

THE Madrid Surgical Society has been formed by Dr. J. Goyanes and a committee of leading Spanish surgeons to encourage surgical research throughout the country and to raise the status of the profession. The new society proposes to encourage the formation of similar bodies in the provinces, and so prepare the way for a National Association of Spanish Surgeons.

WE learn from *Nature* that a large meeting of biologists, including leading representatives of genetics, medicine and anthropology, was held at the London School of Economics on July 21, to consider the question of the present state of research in human genetics and to explore the possibilities of its immediate development. The lack of facilities for research in a subject so vital to the human race as human genetics was generally deplored, and it was decided to seek ways and means to establish in London a central body of experts, who would organize, develop and foster sound research in human genetics within the Empire by means of grants obtained from various sources. The following committee, with power to add to its number, was appointed to take immediate action: Sir Daniel Hall, *chairman*, Sir William Beveridge, Professor F. A. E. Crew, Sir Walter Morley Fletcher, Professor R. Ruggles Gates, Professor J. B. S. Haldane, Professor Lancelot Hogben, Sir Bernard Mallet, Dr. Redcliffe Salaman, Professor C. G. Seligman, and Dr. C. C. Hurst, *secretary*.

THE University of Oregon Medical School is in receipt of information that the Research committee of the American Medical Association has made a grant of $500 to Dr. George E. Burget, professor of physiology, for the prosecution of continuing research in the closed intestinal loop. This represents the fourth grant conferred by the committee for the study of this problem. The committee has also given a grant of $600 to the laboratories of research surgery and research medicine, of the University of Pennsylvania, for work on the function of the gall bladder.

THE John F. Cushing Hall of Engineering, the gift of John F. Cushing, president of the Great Lakes Dredge and Dock Company of Chicago, is now under construction at the University of Notre Dame. An extensive building program started at the University of Notre Dame last winter will be practically completed late in September, giving to the institution two of the most modern dormitories in the Middle West. The buildings will bring the number of residence halls at Notre Dame to fourteen, thus providing quarters for more than 2,600 students. One of the new structures will be called Alumni Hall and the other Dillon Hall.

THE first Congress of Electrical Engineers in South America will be held at Buenos Aires from July 4 to 11, 1932. The principal purpose of the congress is to afford an opportunity to interchange ideas. Tentative programs have been issued and an invitation has been extended to those who go to prepare discussions on some one of the thirty-six subjects suggested or upon other topics. The organization committee comprises fifteen sections, each to be presided over by a well-known engineer. The general secretary of the congress is Robert S. Ascher, of Buenos Aires.

PROFESSOR NELLO BECCARI and Dr. GUIDO GIGLIOLI

are leading an expedition of the Italian Royal Geographic Society which is on its way to British Guiana for six months to conduct zoological and colonial agricultural study.

ACCORDING to the London *Times* the largest scientific party ever sent to Central Australia left Adelaide, Australia, on August 9 for Alice Springs, to study the aborigines and vegetation, birds and animals. The party includes three professors, four medical men, three museum specialists and a cinematographer, and has been organized by Adelaide University, which is continuing and amplifying the studies made by previous expeditions. From Alice Springs the party will proceed several hundred miles northwest, where there are tribes of uncivilized aborigines whose life will be studied. Their language and chants will be phonographically recorded. Scouts have been out some weeks bringing in aborigines, who are establishing a special camp.

THE National Metal Congress and Exposition will take place in Boston during the week of September 21. An extensive exhibition of metals and metal products will be held in connection with the meetings. The congress and exposition are sponsored annually by the American Society for Steel Treating and will be held this year in Boston for the first time since 1924. The four following national technical societies will also meet as part of the congress: the American Society of Mechanical Engineers, the American Institute of Mining and Metallurgical Engineers, the American Welding Society and the Society of Automotive Engineers. The exposition will be on Commonwealth Pier, where more than two hundred manufacturers of metals and metal products will occupy 100,000 square feet of exhibit space.

A SCIENTIFIC expedition to the Arctic has been approved by the U. S. Navy Department to study the aurora borealis for two years under the leadership of Captain F. M. Williams. The expedition will leave in June, 1932, on the fiftieth anniversary of the establishment of the first polar meteorological stations. America was represented in 1882 by the Greely expedition at Fort Conger, Grant Land, which has been selected as the base of the Williams expedition. The expedition has already acquired the services of a Swedish icebreaker, and two airplanes and dogteams will be used. It is proposed to photograph from the air 100,000 square miles of the extreme northern portion of Perry Land. Among the organizations which are said to be cooperating with the expedition are the International Polar Year Commission, the Carnegie Institution, Department of Terrestrial Magnetism, Naval Research Laboratory, the Naval Hydrographic Office and the United States Weather Bureau.

AFTERNOON and evening lectures of public interest have been arranged at the Scripps Institution of Oceanography, according to a recent announcement. Evening lectures will be popular or semi-popular in character, while the afternoon lectures will be more technical. Lectures to be given include those by T. Wayland Vaughan and Burt Richardson.

THE General Board of the University of Cambridge recommends that the following posts be established as from October 1 in connection with the Rockefeller Endowment for Scientific Departments: a university lectureship in cytology in the department of agriculture; a university lectureship in plant physiology and a university lectureship in mycology in the department of botany; an additional university lectureship and an additional university demonstratorship in the department of biochemistry. It is recommended that readerships in the university should be created for: Mr. F. T. Brooks, of Emmanuel College, in mycology; Dr. A. D. Imms, of Christ's College, in entomology, and Mr. James Gray, of King's College, in experimental zoology. A curatorship will be established to the Sedgwick Museum in the department of geology, and a senior curatorship and a junior curatorship of the Museum of Zoology will be established.

FIFTY graduates of the U. S. Naval Academy are spending several weeks in plants of the Westinghouse Electric and Manufacturing Company, where several courses have been arranged for them. These include training for mechanical engineers specializing in turbine work and others who are primarily interested in Diesel engine practice. For electrical engineers, special stress will be put on electric ship propulsion and auxiliaries, both on shipboard and in navy yards. Metallurgists and civil engineers will have work in manufacturing processes and structures.

THE first fish hatchery to be built by the U. S. Government as a part of its five-year building program will be constructed near Rochester, Indiana. The site, which was selected by the Bureau of Fisheries, is located at the outlet of Lake Manitou. Thirty such hatcheries will be constructed in various places in the United States.

ACCORDING to a statement issued by the American Forestry Association, the United States Government has allotted to the Alabama Commission of Forestry $57,320 for the promotion of timber production within the state during the coming year. The funds are to be expended for forest planting and forest-fire protection. The amount allotted is approximately $4,000 more than that for the current year.

THE *Museum News* reports that a standing commission on museums to act in a general advisory capacity has been appointed by the British Govern-

ment. The commission is constituted as follows: Viscount D'Abernon, *chairman;* J. B. Beresford, of the treasury, *secretary;* Evan E. Charteris; Sir Richard Tetley Glazebrook; Lord Hanworth, the Earl of Harewood; Sir George MacDonald; Sir Henry A. Miers; Charles Reed Peers, and Sir Philip Sassoon, M.P. The functions of the commission are: (1) To advise generally on questions relative to the most effective development of the national institutions as a whole, and on any specific questions which may be referred to them from time to time; (2) to promote cooperation between the national institutions themselves, and between the national and provincial institutions; (3) to stimulate the generosity and direct the efforts of those who aspire to become public benefactors.

THE Board of Control of Mental Health Services, with the approval of the British Minister of Health, has, according to a report in the London *Times,* appointed the following to advise the board upon questions arising in connection with scientific and ancillary mental health services: Mr. L. G. Brock, *chairman;* Sir Hubert Bond, Mr. Robert Bruford, Mr. W. E. Lovsey, Mr. T. S. Good, Dr. Adeline Roberts, Mr. J. C. Grime, Professor J. Shaw Bolton and Mr. P. Barter, *secretary.* The mental treatment act, which came into operation on January 1, confers upon local authorities powers to provide for outpatient treatment and for the after-care of mental patients, and, subject to the approval of the Board of Control, to undertake or to contribute to research in regard to mental illness. The Board of Control has appointed the advisory committee to assist them in the consideration of schemes of research submitted for the board's approval, and in regard to such questions as the organization of social services in connection with outpatient treatment and after-care, on which local authorities may seek the board's guidance. On technical questions relating to research the advisory committee will have the expert advice of members of the Medical Research Council's committee on mental disorders.

THE personnel of the new Bureau of Agricultural Engineering of the U. S. Department of Agriculture, which was established about a month ago, includes many members of the former division of agricultural engineering. S. H. McCrory is chief of the bureau, H. H. Barrows is assistant chief, and K. McSorley is secretary. The new divisions are: Irrigation, W. W. McLaughlin, chief; drainage and soil-erosion control, L. A. Jones, chief; mechanical equipment, R. B. Gray, acting chief; structure, Wallace Ashby, chief, and plans and service, M. C. Betts, chief. As special assignments in the bureau, C. A. Bennett is in charge of cotton-ginning investigations and G. R. Boyd, of farm-land development. The editorial and information division is under R. D. Marsden, and the division of administration under G. P. Wolf. S. P. Lyle has been appointed in charge of extension activities and Mrs. Dorothy Wilks, librarian.

DISCUSSION

THE "RICKETTSIAE" AND THE INTRACELLULAR "SYMBIONTS"

KLIGLER and Aschner,[1] in an article on the "Rickettsiae" from certain blood-sucking pupipara, misunderstood my interpretation[2] of the intracellular bacteria found within the American and German roach. These authors, in discussing my work on these diphtheroids (p. 113) state, "The mere fact that they are found in the insect cells is in our opinion no justification for classing them with the *entirely distinctive* group of Rickettsia." This, notwithstanding the fact that in their first sentence they state, "Rickettsia or rickettsia-like organisms have been studied extensively during the last decade; but there is as yet *no clarity as to the nature and precise definition* of this group of microbes." It will be noted in my work that both the terms "Rickettsia" and "Symbionts" were printed in quotes, and that much trouble was taken to demonstrate that the microorganisms discussed were indeed bacteria.

Kligler and Aschner's point of view was anticipated, and for this reason, in 1930,[3] I discussed the whole question of the intracellular "Symbionts" and the "Rickettsiae" at length. I still maintain that size and tinctorial properties alone do not constitute valid taxonomic characters and that a natural classification is based upon general biological relationships. Creating new orders, families, genera and species without sufficient evidence is termed "splitting" by biologists and is considered extremely unconservative. The most conservative workers always attempt to place new organisms within established systems.

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[1] *J. Bacteriology,* 22: 103–114, 1931.

[2] *J. Exp. Med.,* 51: 59–82, 1930; *ibid.,* 51: 903–907, 1930.

[3] *Archives of Pathology,* 9: 71–96, 1930; *ibid.,* 9: 557–576, 1930.

THE CAUSE OF MOTTLED ENAMEL

MOTTLED enamel, a tooth defect first reported in the United States by Messrs. G. V. Black and F. S. McKay[1] in 1916, is wide-spread. A recent Public Health Report[2] by Kempf and McKay shows mottled enamel to exist in districts in Colorado, Texas, Virginia, Arizona, Italy, Holland, China, Mexico, Spain, Argentina, Cape Verde Islands, Bahama Islands and other South American and South African countries. Other centers have been reported recently in Illinois, North Dakota and Minnesota.

Mottled enamel is usually characterized by dull white or "paper white" patches scattered irregularly over the surface of the tooth. In some cases the whole tooth surface shows this dead white, unglazed appearance. In many cases the enamel is badly pitted. Mottled teeth probably erupt with the intercementing material absent. They may or may not become stained later.

From experiments in progress in the nutrition laboratory at the University of Arizona it appears evident that the causative factor of mottled enamel lies in the water supply of the afflicted communities, a view long since held by McKay. By several lines of evidence in our laboratory the destructive action of the water upon the developing enamel of the teeth has been shown to be due to its content of flourine. A condition resembling mottled enamel has been produced in the incisors of rats by the use of water obtained from St. David, Arizona, an endemic community. This water was reduced to one eighth of its original volume by evaporation and given to rats to drink. Water residues were incorporated in the rations of other rats. In both cases a defect of the teeth was produced which was similar, if not identical, to that condition produced in litter mates by the addition of sodium flouride to their ration. The teeth were chalky white, and in many cases decidedly pitted. An abnormal effect in the structure of rats' teeth produced by the feeding of sodium flouride was demonstrated in 1925 by McCollum and his coworkers,[3] but was not at that time associated with mottled enamel. The incisors were reported to be abnormal in color, the orange tint normally seen on their anterior surfaces being nearly absent.

Quantitative analysis of the water from St. David and other afflicted communities has shown a high content of flourine as compared with but small amounts present in the waters of neighboring unaffected regions.

Geologic relations to water supply are being investigated. The finding of prehistoric animals of the late Cenozoic age (mastodons) the tusks and bones of which are unusually high in calcium flouride suggests a possible source of enrichment of the water in flourine in that community. The deposit of cryolite (Na_3AlF_6) on Pike's Peak suggests the source of contamination of the water supply of Colorado Springs, another community in which mottled enamel is endemic.

Gautier[4] has analyzed waters from many different sources for flourine and has shown that waters in volcanic regions, waters produced eruptively and so-called mineral waters contain higher concentrations of flourine.

The relation between the degree of mottling and the concentration of flourine in the drinking water supply of humans is being investigated.

There is some evidence in the author's laboratory to show that certain types of dietary inadequacies make the destructive action of flourine containing waters more pronounced.

Work upon all these lines is being actively pursued.

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APRIL 27, 1931

RELIC OF AN EARLY AERIAL POST

QUOTING from the Encyclopedia Britannica, eleventh edition, vol. 1, p. 264:

> The first balloon voyage across the English Channel was accomplished by Jean Pierre Blanchard (1753–1809) and Dr. J. Jeffries, an American physician, on the 7th of January, 1785. . . . In their channel crossing Blanchard and his companion, who started from Dover, when about one-third across found themselves descending, and threw out every available thing from the boat or car. When about three-quarters across, they were descending again, and had to throw out not only the anchor and cords, but also to strip and throw away a part of their clothing, after which they found they were rising, and their last resource, viz., to cut away the car, was rendered unnecessary. As they approached the shore, the balloon arose, describing a magnificent arch high over the land. They descended in the forest of Guinnes.

It may be added that a fine monument has been erected at the spot where they landed.

On this journey from Dover Dr. John Jeffries wrote a card to his friend, Mr. Thayer, and dropped it before passing from the English coast. This yellowed and stained bit of early aerial post has recently come into the possession of the Snell Museum of

[1] G. V. Black and F. S. McKay, "Mottled Teeth," *Dental Cosmos*, June 16, 1916.

[2] G. A. Kempf and F. S. McKay, "Mottled Enamel in a Segregated Population," *Public Health Reports*, 45, p. 2923, 1930.

[3] McCollum and coworkers, "The Effect of Additions of Flourine to the Diet of Rats on the Quality of Their Teeth," *Jour. Biol. Chem.*, 63: 553, 1925.

[4] A. Gautier and P. Clausmann, "Le Flour dans les Eaux Minerales," *Compt. Rend. Acad.*, 158: 1631, 1914.

Physics at Amherst College. It was presented to the college many years ago by Thatcher Thayer, D.D., of the class of 1831, Amherst, a descendant of the Thayer to whom it was originally written.

The post-card was written with a lead pencil, and is fairly legible except for a stain in one corner. The inscription is as follows:

From the Balloon above the Clouds.

Let this afford one proof, my dear Mr. Thayer, that *no separation shall make me unmindful of you*,—have confidence,—hopeful that happier days are in store for you, my dear Mr. T. I wish you much pleasure,—believe me as I ever have been,

faithfully yours,

J. JEFFRIES.

This little bit of post-card was prophetic of the days when the Wright brothers' "Strange Contraption" should rise at Kitty Hawk in 1903, when Louis Blériot, 1909, should drive an aeroplane from France to the white cliffs at Dover, when aeroplanes and dirigibles should become the speedy carriers of our mails and when we should see

> . . . the heavens fill with commerce,
> argosies of magic sails,
> Pilots of the purple twilight,
> dropping down with costly bales.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

THE ABDOMINAL WINDOW

SIMPLIFICATION of methods and apparatus in experimental procedures is a goal that is earnestly sought after in teaching. Too frequently, however, when the goal is attained, the results are disappointing. In our laboratory we have devised a piece of apparatus in our teaching courses which has several attractive features that are of interest to teachers, especially those who must combine economy with success. The abdominal window is simple in construction, the results are gratifying, and the expense is almost nothing. There have been many methods devised for observing the movements of stomach and intestines in anesthetized animals; *e.g.*, submerging the intestines under saline solution with the abdominal wall open and making direct observations; feeding a meal mixed with material opaque to x-ray and observing the contractions of the intestines on the opaque material; opening the abdomen in the midline and inserting a watch-glass under the abdominal muscles but over the intestines; opening the abdomen and without further preparation observing the movements as long as they last. Those who have used the above methods will recall readily certain vital objections to each method especially for use in class work.

The abdominal window which we have been using since 1922 in our laboratory is not a new principle but a modification which has proved very successful here. The method was demonstrated at the meeting of the Federation of American Societies for Experimental Biology at Chicago in March, 1930. The window is a modification of the old watch-glass method. One of the most annoying features with that method was the tendency for a loop of intestine to move out of the field of observation, especially after normal observations had been obtained and a procedure inaugurated whose effect one wished to observe. The watch glass was easily placed, but the results were too frequently disappointing. We felt that a larger field of observation should be provided in order to obviate the disappearance of a particular loop of intestine in which we had become interested.

The abdominal window which we have developed is shown in Fig. 1. It consists of a piece of old x-ray film (A) which has had the coating removed and which was cut in the shape shown. It is 7″ long, 4½″ wide. This has been found to be a satisfactory size for both cats and rabbits. We have used it mostly in rabbits. In the upper third is cut a hole 1¼″ in diameter and centered laterally. A lid or door (B) is then cut from another piece of film of such size and shape that it may effectually close this opening or expose it when swung on the hinge (C). This hinge is made with an ordinary office combination punch and eyelet machine. Near the outer margin of the lid (about ½″) a slit is cut just wide enough to permit the insertion of one jaw of a No. 46 Dennison card holder (E). This clip insures the lid being fastened shut. Release of the clip permits the opening of the hole in the window. Woven back and forth through the lid is a wire (D) which is bent slightly with its concavity downward. We used the wire of a No. 1 paper clip straightened out. The object of this wire is to prevent the lid from curling up laterally when it becomes warm. The Dennison clip and the hinge prevent curling in its long diameter. The object of the lid is to permit the making of injections directly into the loop of an intestine or to make applications of agents directly on the outside of the intestinal tract.

The placing of the abdominal window requires a little more operative procedure than the watch glass,

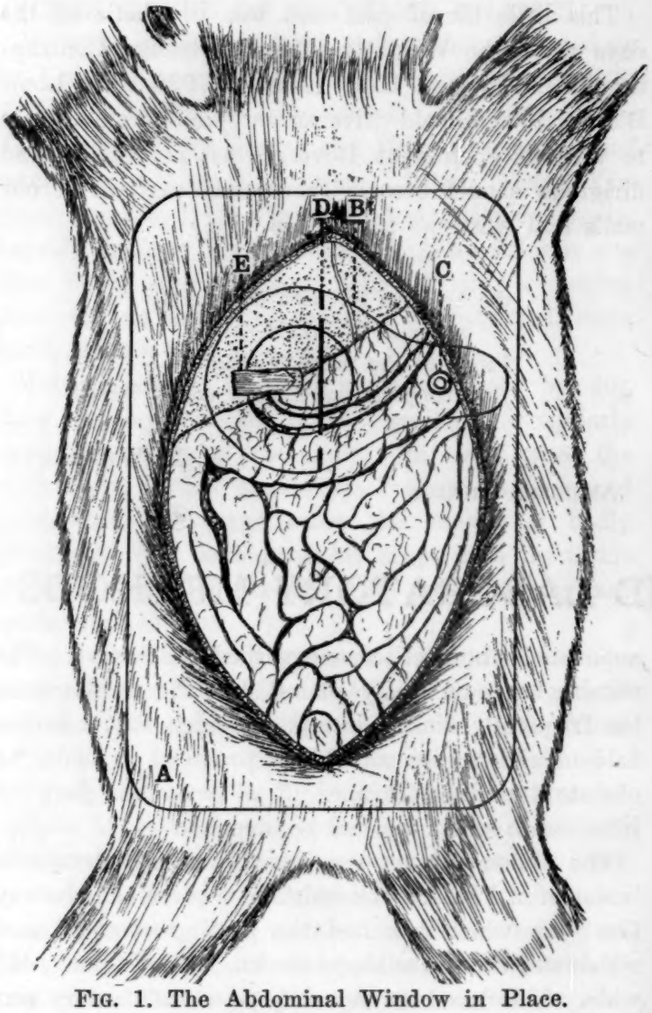

FIG. 1. The Abdominal Window in Place. (Semi-diagrammatic.)

but the returns in successful observations more than counterbalance the extra work. We have used the following technique. After thorough anesthetization with urethane or other anesthetics, a median abdominal skin incision is made two inches less in length than the abdominal window. The skin is then separated from the underlying muscles, the *separation* extending one inch *beyond each end* of the lineal incision in the skin and laterally almost to the spinal column. This is fairly easily accomplished in the rabbit, not so easily in the cat, and more difficult and bloody in either animal if it is a female, because of the mammary glands.

The skin having been thus thoroughly separated, a double row of ligatures is laid through the muscles of the upper abdomen in a line at right angles to the long axis of the animal's body, and the muscles cut across between the ligatures. A similar double line of ligatures is laid across the lower abdomen and the muscles cut between them. Care should be taken of course that the underlying intestines or bladder are not included in the ligatures or injured. We use eight ligatures in the upper abdomen and four in the lower abdomen. Each ligature extends over an inch or one and one half inches, and includes a fairly large mass of muscle tissue. Technique of preparation, however, may be varied to suit one's personal inclinations. The muscles then are separated longitudinally by an incision made in the median line. Then they are rolled back on either side from the median line, thereby exposing a large field to view. A loose ligature may be laid under one of the loops which will be under the opening in the window.

The abdominal window is then placed *under* the skin, but *on* the abdominal muscles which have been rolled back. With the lid of the window open, the loose ligature, previously placed under a loop of intestine, may be drawn up through the opening and left outside. The lid is then closed and fastened by means of the Dennison clip. If the large intestine occupies too much space in the center of the field (especially in rabbits), it may be moved to one side before the window is placed.

In a few minutes after placing the window, it becomes sealed from the skin oozing and so is practically air-tight. The small amount of air that may enter through the lid is of no consequence, as movements continue uninterruptedly. No fluid is required to be placed in the abdomen. Fog may collect on the under surface of the window and is due to the unequal temperature of the room and the inside of the abdomen. This may be obviated by keeping hot moist towels laid over the window between observations. Whether fogging occurs or not, it is a good plan to keep hot towels laid over the window especially in a cool laboratory for, unless the animal is on a heating pad, its temperature tends to drop rapidly because of the thin window, and therefore the intestinal movements may be much retarded or stopped altogether.

The advantage of this method is the large field for investigation and the ease of making the observations. A loop of intestine does not depart from the field of observation at the most inopportune moment. Furthermore, it is an easy procedure to secure a loop of intestine and bring it up where a hypodermic needle may be inserted into the lumen and injections made in that manner. The loop is then returned inside the abdomen and the lid closed. In the same manner applications directly to the outside of the gut may be made. Properly insulated wires may be introduced through this opening and stimulations of nerves or muscles made directly. The method is admirably adapted not only to the observation of intestinal movements, but also for the observation of the condition of the blood vessels, *i.e.*, whether dilated or contracted; and for observations of other abdominal organs, such as bladder, uterus, kidneys, etc.

While the method was devised primarily for teaching and demonstration purposes, it may be used in research, and in the physiological laboratory of this school Dr. Leland C. Wyman has carried on an investigation in which he made use of the window to observe vascular changes in the intestines of a rat.

The abdominal window herein described is simple, efficient, inexpensive, and has the added advantage that it maintains the interest of students because they are able to carry on their experiments easily and successfully.

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A METHOD FOR RIPENING HAEMATOXYLIN SOLUTIONS RAPIDLY

THE writers are calling the attention of biological workers to the ease in preparation of various haematoxylin solutions which ordinarily require a rather long ripening process. Within our knowledge, this method has not been reported heretofore. Ehrlich's or Delafield's haematoxylin solutions are prepared in the usual way. When ripening is to be brought about, the solution is placed in a very wide and somewhat shallow evaporating dish and exposed at a distance of approximately two feet, to any rather powerful quartz mercury vapor light. The rapidly darkening solution should be stirred frequently. Delafield's solution will be ready for use after an exposure of about two hours, and some three or four hours are necessary for ripening Ehrlich's solution. A very vigorous staining solution results. This method can also be applied to the ripening of a one half per cent. haematoxylin solution for use in Haidenhain's iron-alum stain except that the exposure to the quartz mercury arc is very much shorter.

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SPECIAL ARTICLES

SEXUAL RHYTHM IN THE CALIFORNIA OYSTER (OSTREA LURIDA)

IT has been known for many years[1] that the common edible oyster of our Pacific coast is hermaphroditic and viviparous but no definite information has been hitherto available as to the sequence of the sexual phases in this species. With the cooperation of Professor W. E. Allen, of the Scripps Institution of Oceanography, cement and wooden experimental blocks have been placed in the water at frequent intervals and at all seasons during the past five years. From these blocks, which were suspended from the Institution's pier at La Jolla, California, a fairly complete series of oysters of approximately known ages has been obtained.

Weekly or biweekly collections were made, at which time one face of a block was scraped free from attached organisms, including oysters. The block was then returned to the water to gather a new crop of the free-swimming stages of such organisms as were at that time ready for attachment.

Examination of such blocks shows that the oyster in that locality is in process of reproduction during at least seven months of the year,[2] or for a longer period in those years in which the water remains unusually long above the critical temperature of about 16° C. in the autumn or reaches this temperature earlier than usual in the late winter or spring. For it is found that spawning is inhibited when the water falls below this temperature, to be resumed when the critical point is again reached.

Microscopic sections of the gonads show that some members of the oyster population in that locality have ripe sexual products at all seasons of the year and that all possible combinations of sexual phases are represented. Immature individuals in the male phase, young hermaphrodites, inter-sexual forms predominantly of one sex or of the other, with all conceivable transition stages, are always to be found, as Stafford has long since reported.[1] Some of these are evidently young, others are mature and still others are obviously old, but they offer only vague testimony as to the sexual conditions appertaining to any one individual during its lifetime. By taking a series of oysters of definitely known ages, on the other hand, such as has become available from these experimental blocks, the sequence of sexual phases can be followed with little chance of error.

In the young animal the first trace of the gonad appears at the age of about eight weeks. The few cells composing this gonad show no distinguishing characteristics of sexual differentiation, but at the age of twelve to sixteen weeks each gonad in every animal studied shows that both primitive ovogonia and spermatogonia are present.

The spermatogonia, however, proliferate more rapidly than do the ovogonia and the gonad soon

[1] Jos. Stafford, The Canadian oyster. *Comm. of Conservation*, Canada, pp. 1–159, 1913.
[2] W. R. Coe, *Anat. Rec.*, 47: 359, 1930.

acquires the characteristics of a spermary, although ovogonia and ovocytes are always present. Spermatogenesis quickly follows if the temperature is sufficiently warm and the ripe spermatozoa are ready to be discharged when the oyster is about five months of age.

This is typical protandry, and this evidently occurs in all individuals, for no exception has been found. The spermatozoa are held firmly together in spherical masses, the so-called sperm-balls, each ball consisting of from about 250 to 2,000 or more ripe spermatozoa, all of which have been derived from a single primary spermatogonium. Before this initial male phase has been completed and before any of the sperm-balls have been discharged, the proliferation of the ovogonia and their transformation into ovocytes is in progress. Most of the sperm-balls are then discharged from the body, whereupon the animal assumes the first female phase, although some sperm-balls are always left in the genital ducts, and many spermatogonia for the subsequent male phase are present in the gonads.

In the early female phase the original primary gonads increase greatly in size by the growth of the ovarian tubules into the underlying connective tissue, forming the secondary gonads. In these tubules the ovocytes build up their yolk materials and at the age of about six months the climax of the first female phase is reached. Ovulation then occurs, the eggs being retained in the mantle cavity of the parent during fertilization and cleavage and through development until the embryos have become provided with a bivalved, straight-hinged shell—a period of approximately ten to twelve days, perhaps. It seems not improbable that ovulation takes place only when the animal is stimulated by the presence in the water of spermatozoa of other individuals, as Galtsoff[3] has found to be the case in other species.

In the process of ovulation the eggs frequently mingle in the genital ducts with the sperm-balls remaining from the preceding male phase, but self-fertilization can not occur, at least not until the gametes have reached the sea water in the mantle cavity, for the spermatozoa are only liberated by the solvent action of the water on the substance of the sperm-ball. Even then there is no evidence that self-fertilization takes place, for it is not known whether the gametes from the same individual are mutually reactive.

Not all the ripe ova are discharged at the first ovulation. Those remaining in the gonads may be absorbed by phagocytosis, or a second ovulation may occur as soon as the first crop of larvae has been spawned. Many other ova, evidently not quite ripe, are retained to form the basis for the second female phase.

While the embryos are developing within the mantle cavity the spermatogonia remaining in the gonads begin a rapid spermatogenesis and even by the time the embryos have been spawned the second male phase has been reached. The number of sperm-balls produced is now vastly greater than in the first male phase and a much greater proportion of them contain the maximum number of spermatozoa. If the animal is well nourished some hundreds of thousands of such sperm masses are formed, with upwards of 2,000 spermatozoa in each.

Given the suitable stimulus, most of the sperm balls will be discharged, a few remaining as before. The body of the oyster has then become soft, flabby and translucent, presenting a marked contrast to its plump whitish condition preceding the discharge of the gametes. A period of recuperation follows. The body grows larger and nutrient materials are then stored in the tissues in preparation for the following sexual phases. The time required will evidently depend upon the metabolic conditions of the animal.

Examination of the gonad during this resting period shows the preparation for a second female phase. When completed, if the environmental conditions are suitable, a new crop of embryos will appear in the mantle cavity, and coincidentally therewith the proliferation of spermatogonia for the third male phase. Following the ripening and discharge of the sperm will come another recuperation period. And, apparently, these alternating sexual phases may be repeated regularly throughout the remainder of the animal's life. But it is not at all improbable that in certain individuals, and possibly in some hereditary strains, one sexual phase or the other may be considerably reduced in older animals, with a corresponding tendency toward a dioecious condition. It is also not unlikely that in the colder portion of the range of the species a single annual rhythm or even a biennial rhythm may be found to occur, as is the case with the European oyster in some localities.[4,5,6]

Following the initial male phase, we thus find in the California oyster a regularly repeated sexual rhythm in (*a*) female, (*b*) male and (*c*) recuperation sequence for each individual. The conclusion follows that the fertilized eggs are all alike in regard to their primary sexual inheritance, with an associated hereditary mechanism, perhaps metabolic in nature, which is responsible for the rhythmical alternation of the sexual phases. Environmental conditions determine the rate of the sequence, and the

[3] P. S. Galtsoff, *Proc. Nat. Acad. Sci.*, 16: 555–559, 1930.

[4] P. P. C. Hoeck, *Tids. Nederl. Dierk. Ver.*, Deel 1, Suppl., 113–253, 1883–4.

[5] R. Spärck, *Rep. Dan. Biol. Sta.*, 30: 1–84, 1925.

[6] J. H. Orton, *Jour. Mar. Biol. Asso.*, 14: 967–1045, 1926–7.

time occupied by each of the successive phases, but there is as yet no evidence that the sequence is altered.

This statement needs to be qualified by the additional remark that the rhythm may be interrupted at any point by the advent of low temperature and presumably by any unfavorable metabolic conditions, to be resumed again when a suitable environment is restored.

It must be remembered that spawning occurs on the coast of Southern California during seven or more months of the year, so that on approach of cool weather the population will be represented by individuals which are in all stages of growth and reproduction, from larvae to old adults. Growth continues below the critical temperature but the discharge of sexual products is inhibited. The phase in which the animal enters this period will be retained throughout the winter unless the time of inhibition happens to coincide with the completion of one of the sexual phases.

A further complication results from the fact that not all parts of the reproductive system reach any one phase of sexuality at the same time, so that we shall find one portion in a somewhat different phase than is another area in the same animal. And finally, there are all grades of intersexuality as one phase passes into the next. This is particularly true of the younger animals, there being no exclusively male or female individuals among them at any season.

With increasing age, however, the intergrading stages become reduced and the sexual phase may be occasionally strictly male or female except for the minute gonia which anticipate the next phase. But in nearly all cases a few sperm-balls remain in some part of the system through the female phase and, conversely, a few ovocytes in the male phase recall the preceding part of the rhythm or foretell the next.

We may conclude, then, that *Ostrea lurida*, like the European *O. edulis*,[4,5,6] is a protandric hermaphrodite, with an alternating rhythm of female and male phases throughout life.[7,8]

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[7] Of some sixty species of the genus *Ostrea* ten are known to be monoecious. In some of the others hermaphroditism has been found in young animals or in some localities, while in one species, classed as dioecious, a considerable proportion of individuals have recently been shown by Amemiya (*Proc. Imp. Acad. Tokyo*, 5: 284–286, 1929) to change their sex during the winter.

[8] In a recent number of SCIENCE (74: 71, 1931) Burkenroad presents evidence that even *O. virginica* on the coast of Louisiana is protandrous, with an incidence of hermaphroditism of about 1 per cent. in the general population. The writer has also found a considerable percentage of intersexuality in small individuals of the same species at Woods Hole, Massachusetts.

RICE BRAN, A PREVENTIVE OF PEROSIS (DEFORMING LEG WEAKNESS) IN CHICKENS[1]

IN the fall of 1929 the animal husbandry division of the Bureau of Animal Industry and the departments of poultry husbandry of several Southern and Southwestern state agricultural experiment stations organized an informal cooperative project for the purpose of comparing, on a weight-for-weight basis, different feeding stuffs when included in a so-called "uniform" diet for growing chickens. During the spring and summer of 1930 the following experiment stations used the "uniform" diet in some of their feeding experiments with growing chicks: Kansas, Louisiana, New Mexico, Missouri, Texas, the U. S. Poultry Experiment Station, Glendale, Arizona, and the U. S. Animal Husbandry Experiment Farm, Beltsville, Maryland.

Several of the stations reported that when the "uniform diet" was fed to chicks kept in confinement a high percentage of them became afflicted with perosis (deforming leg weakness). One of the writers (W. M. G.), observed, however, that when 10 and 20 per cent. of rice bran replaced equivalent amounts of wheat in the "uniform" diet, no cases of perosis occurred. Soon after this observation was made, the other writer (H. W. T.) started a series of experiments for the purpose of studying the cause of the beneficial effect of rice bran in preventing this condition.

The results of these experiments are now being written up for publication. Since perosis, or leg weakness, has been a serious obstacle to the rearing of chickens in confinement, it seems to be advisable to call attention, at this time, to some of the conclusions drawn from these experiments.

Perosis, or deforming leg weakness, in chickens is a condition of dietary origin, in which the legs become deformed in various ways. The first observable symptoms are a slight puffiness of the metatarsal-tibia joints and a marked tendency on the part of the chicks to rest for long periods of time in a squatting position with the legs doubled up under them. As the condition becomes worse, the joints become more enlarged and a pronounced bending of the tibiae and tarsometatarsi may occur. Union of the diaphyses and epiphyses at the distal end of the tibiae is greatly delayed, or fails to occur. Sometimes there is a marked separation of the epiphyses from the diaphyses and the large tendons slip from their condiles leaving the metatarsal-tibia joints permanently deformed.

[1] Published with the permission of the director of the Louisiana Agricultural Experiment Station and the chief of the Bureau of Animal Industry of the U. S. Department of Agriculture.

This condition can be partially prevented by (1) adjusting the calcium-phosphorus ratio of the diet to a more suitable value, and (2) by adding from 6 to 10 per cent. of rice bran to the diet. When both of these changes are made simultaneously, it is possible to prevent the condition entirely. In the presence of 6 to 10 per cent. of rice bran, a dietary calcium-phosphorus ratio of 2.5:1 was found to be effective in preventing perosis.

It seems probable that in the past this condition has often been confused with rickets. That the condition is not a truly rachitic one is indicated by the following observations: (1) The ash content of the leg bones may be, and nearly always is, normal, and (2) the calcium and inorganic phosphorus content of the blood serum falls within the normal range.

In view of the experimental findings it seems necessary to postulate that, in addition to vitamin D, another accessory food factor, or vitamin, is necessary for the proper development of the leg bones (and possibly of the other bones) of the growing chicken. It is suggested that water-alcohol extracts of rice bran may be of value in treating refractory cases of rickets in human babies, when there is little or no response to treatment with viosterol, or cod-liver oil, alone.

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THE FORMATION OF GLYCINE FROM SERINE[1]

IN a recent paper, Daft and Coghill[2] have recorded the isolation of glycine in 28 per cent. yield from the vigorous alkaline hydrolysis of another naturally occurring amino acid, serine. While the reaction may appear anomalous, it is readily explained on the basis of a theory which the writer is finding useful for the explanation of the sensitivity toward alkalies of cysteine and its derivatives.

The reaction:

$$\text{(A.)}\quad R'CHO + H_3CC(:O)R \rightleftarrows R'CH(OH)CH_2C(:O)R \rightleftarrows R'CH:CHC(:O)R + H_2O.$$

is very well known, as is the fact that all its stages are reversible, the various changes being powerfully catalysed by alkalies.

Glycine, $H_2NCH_2C(:O)OH$, is a substance which contains, at least formally, the same groups as the methyl ketone of equation A. It is generally recognized that the carboxyl group is much less, though not indefinitely less, active in the respects here discussed, than the keto group. Nevertheless, reactions analogous to those indicated in equation A take place with glycine when it is substituted for the ketone represented in that equation. As a good example, the customary synthesis of β-phenyl serine[3] from benzaldehyde and glycine may be mentioned.

In the writer's opinion, the formation of glycine from serine as described by Daft and Coghill is only a reversal of this reaction:

$$\text{(B).}\quad H_2C(OH)CH(NH_2)CO_2H \rightarrow H_2CO + H_2C(NH_2)CO_2H.$$

It is perhaps worth while, in this connection, to call attention to the fact that methylenemalonic ester, $H_2C:C(CO_2C_2H_5)_2$, needs no stronger alkali than ammonia to give[4] a formaldehyde derivative (hexamethylenetetramine) and malonamide. This reaction, in which hydroxymethylamalonic ester is undoubtedly an intermediate, is quite analogous to that described for serine, but occurs under much gentler conditions, due presumably to the greater activating effect of two carboxyl groups, and to the fact that the latter are in this case esterified.

It may be added that when cysteine is hydrolyzed with alkali, no formation of glycine has as yet been observed. The reaction takes instead the other course suggested by equation A, and hydrogen sulfide is split out[5] in the first of a series of reactions. A strictly analogous reaction, with loss of water, apparently accounts for the major portion of serine when the latter is similarly treated.

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